TUBERCULOSIS OF THE ELBOW, ARTHROPLASTY.

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THE following is a brief account of a successful attempt to reëstablish a hinge joint at the elbow, after resection of the joint for tuberculosis. The result is the more interesting since the case has been followed for three years after operation:

History, R. P., 18 yrs.—She was first seen at the Massachusetts General Hospital in 1903, where she was successfully operated upon for tubercular glands of the neck. There has been no recurrence after four years.

In the following year, March 18, 1904, she again appeared at the Massachusetts General Hospital with a history of pain in the right elbow. The following notes were made at that time:

"About one month ago R. P. began to have pain in the right elbow, when she used that arm, and this pain has continued ever since. An attempt to straighten the elbow is unsuccessful, and causes great pain. Heat and swelling have been present during the period when the pain has been noted. The pain is worse at night, and is relieved somewhat by elevating the elbow on the pillow. X-ray examination and internal angular splint advised.

The day after the first examination the patient returned and was re-examined with the X-ray plate for comparison. The elbow gave signs of fluctuation, and the X-ray plate showed foci in the ulna, with a certain amount of disintegration of the joint. Operation was advised but refused."

The girl went about to the various out-patient clinics of the city, where she was advised to have an operation. She came to me in June, 1904. I advised, and performed immediately resection of the elbow joint.

Examination.—At the time of the operation the elbow was large, swollen and tender. On either side of the olecranon process and the biceps tendon a bulging mass presented which gave signs of fluctuation. A short time before I first saw it, the joint had been punctured on its inner aspect, from which a

mixed infection had resulted, marked by a temperature elevation to 104°, increased tenderness, and constitutional symptoms. *The motions* of the joint, at this time, were limited. The forearm was habitually extended to about 120°, though it could be flexed to 80°, an angular excursion of some 40°. This motion was obtained with great difficulty, and at the expense of eliciting severe pain in and around the joint. As to pronation and supination, the wrist could be twisted from a position of 90° pronation to 45° supination; in other words, rotatory motion at the elbow joint was much limited. The bulging synovial cavity, with the surrounding infiltrated structures, constituted a tumor about four inches in diameter, antero-posteriorly, and about four and one-half inches measured in a lateral plane. The physical signs, therefore, showed advanced disease of the elbow joint with distension of the joint capsule, spasm of the adjacent muscles, and infiltration of the soft parts in relation.

A series of operations was done in this case. The patient was etherized on eight occasions, on all but three of which the procedure was in the nature of an ether dressing: to break up adhesions, or to curette a cavity.

First Operation, June, 1904.—Incisions: These were three and, together formed an H-shaped figure placed in the following manner:

(1) A five-inch incision was made over the olecranon, parallel with the long axis of the bone. This passed through the triceps tendon and muscle down to the capsule.

(2) A second four-inch incision was made parallel with the first over the internal condyle.

(3) A cross-cut connected the two previously made incisions. This was made with the greatest care to avoid wounding the ulnar nerve.

The joint was opened and found to be disintegrated and filled with grumous, infected material. The flaps were reflected, and the disease followed upwards and downwards into the arm and the forearm. The forearm muscles were separated from their attachments to the condyles of the humerus, and subperiosteal resection done four inches above the condyles. The periosteum was left intact nearly to the joint.

The upper halves of the ulna and the radius were riddled with disease, and by curettage and excision the mischief was

cleaned out. The removal of the foci and their extensions required the resection of the head of the *radius* close to the bicipital attachment. Behind this a shell of periosteum remained, as the interior of the bone was scraped away for nearly its upper half. In the *ulna,* complete section was done just behind the coronoid process. From this point a narrow spicule of bone reached back for two inches, until it lost itself in the periosteal cavity which was the relic of the upper half of the ulna, after scraping away the disease. The bony bit left behind at the upper extremity of the ulna overlapped, by two and one-half inches, the point reached by the periosteal remnant of the radius. As will be seen later, the subsequent development of this bony ulnar extremity proved of marked mechanical value in the construction of a tightly-fitting joint. The interosseous nerve was identified during the dissection and preserved. The longitudinal cuts were approximated with interrupted sutures, since the tissues were too infected to allow suture by layers. The cross-cut was left open, and the gap, thus provided, was utilized for drainage purposes. The joint drained for eight weeks and various materials were employed to keep it open while the periosteal cavities were filling; silk-worm gut strands arranged in fagots proved very satisfactory.

The extremity was put up in extension and held there for two weeks. During this time the periosteal sacs had become slightly stiffened, and a move was made to effect more complete isolation of the bones above and below the operative site.

Second Operation, Two Weeks After First.—The patient was etherized and gauze packing insinuated between the upper and the lower arms, thus filling the granulating cavity left at the field of the previous operation. The extremity was again placed in extension, and thus retained for the two weeks following.

Third Operation, Four Weeks After First.—There seemed to be a distinct rigidity discernable in the region of the periosteal shells. The sponge packing was removed, and the bones of the lower arm lifted until their cut ends bore upon the shell of growing bone, which was now replacing the old, and forming the new lower articular surface of the humerus. The overlapping fragment of the ulna was passed by the humerus to the inner side, thus permitting the approach of the radius to and its articulation with the humerus.

The extremity was fixed in a position of acute flexion. In

this posture the bones were immobilized for two months by means of internal splints angular to various degrees of acuteness. Passive angular and rotary motions were undertaken two days after the third operation, the arm being restored to the splint after the exercise.

Ether was given subsequently five times, as alluded to earlier, sometimes with the intention of freeing adhesions, at others of loosening tags of detritus caught in the sinus.

End Results.—There is a *shortening* of four inches in the affected arm. An effort was made at the first operation to save part of the epiphyseal line on the ulna, but it is doubtful whether it was successful. If my measurements do not deceive me, during the past year the difference in length of the two arms has been reduced nearly one inch.

Motions: Rotatory is perfect. In pronation the projecting ulnar process hugs tightly the humerus, thus gaining a *point d'appui*, so that the spiral rotation of the radius over the ulna causes no lateral displacement or wobbling. Perfect supination is present.

Angular Motions.—Flexion—to 36 degrees; extension—to 150.5 degrees.

Motions of the Fingers.—These are perfect, strong extension and flexion, being both accomplished with freedom.

The Mechanism of the Joint.

Angular Motion.—As a whole, *during extension,* the ends of the forearm bones rest near the upper edge of the notch in the humerus. The ulna, at this time, is separated from the humerus for about one-quarter inch; the end of the radius remains attached to the ulna, but in front of the humerus. As the arm is flexed the radius and the ulna are pushed backwards and downwards; backwards until close articulation with the humerus occurs, whence it glides downwards for about a half inch along the curve of the socket, where it rests during the completion of flexion.

Rotary Motion.—In supination the radius lies in front of the humerus, slightly to the inner side, in close relation with the ulnar end. At this point the ulna forms a hook and articulates with the other two bones as follows: the lower half

of the hook supports the radius, and provides a fulcrum for the same, quite similar in principle to the relationship of these bones in a normal joint. The upper half of the hook bears upon the humerus. *When pronation occurs* the new radial head turns in its new bed, while the shaft twists over and to the inner side of the ulna. This twist pushes the ulnar hook outwards until it meets the humerus, when ulna and humerus lock firmly together, and here they remain, in close embrace, while complete pronation is effected.

Conclusion.—No general conclusions can be drawn from one case. It would seem, however, that a good mechanical

FIG. 1. Cross section. Extension. Supination.

FIG. 2. Cross section. Flexion. Supination.

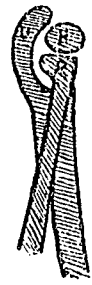

FIG. 3. Cross section. ¼ 90° Flexion Pronation.

outcome should generally follow the employment of the technique described above, since this successful result was obtained in the face of unusual difficulties. The widespread tubercular involvment of the bones and the soft parts, the mixed infection, and the indolence of the reparative process, presented a discouraging picture. In cases of ankylosis in which the original infection had subsided, these primary obstacles to success would be minimized.

Many attempts have previously been made to obtain a fulcrum for the play of the arm bones. The introduction of soft parts between the bony articulating surfaces may prevent ankylosis, but it cramps the motions by omitting to provide for a socket.

The obvious disadvantages of a flail joint need no comment. The two factors which contributed chiefly to the restored elbow function of my case were: (1) the new socket in the humerus, (2) the firm grasp of the humerus by the hook of the ulna.

It is now three years after operation, and the girl is working in a factory eight hours a day, and often carries heavy weights up and down stairs with the operated arm. The gross and the X-ray photographs are explained by their legends.

FIG. IV.

Final result of arthroplasty of right elbow. Lateral view, extended to 150.5°, 1907, 3 years after operation.

FIG. V.

Final result of arthroplasty, right elbow. Lateral view, flexed to 36°, 1907. Complete flexion.

FIG. VI.

Arthroplasty, right elbow. Lateral view, flexed to 41°, corresponds to Fig. V. Note relation of forearm bones to tip of humerus.

FIG. VII.

Arthroplasty, right elbow. Lateral view, extended to 150.5°, 1907, corresponds with Fig. IV. Note: separation of bones during extension, scattered bony deposits about joint, tip of ulnar process slightly overlaps humerus.

FIG. VIII.

Arthroplasty, right elbow. Antero-external-posterior view, extended to 150.5°, viewed from behind: 1907, corresponds with Fig. IV. This view is not exactly a front one, but is taken somewhat from the outside as well. This throws the shadow of the forearm bones to the inner side, but it brings out the hook of the humerus. Note hook of ulna, with its radial articulation, also end of radius. The irregularities are undoubtedly filled with soft parts.